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Notes on the ecology of corticolous epiphyte dwellers

2. Collembola[1])

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With 4 figures

1. Introduction

Despite their relative simplicity and the peculiarity of their component populations, corticolous communities have been neglected by ecologists. In addition, the few studies devoted to the description of corticolous communities deal with only one order, for instance, with Oribatida or with Collembola. Lastly, corticolous communities are usually perceived as a sole community analyzed in opposition to others found on stones or in litter.

However, the discontinuous bark cover formed by epiphytes provides a mosaic of microhabitats for the fauna. This heterogeneity should encourage diverse assemblages of populations and lead to the coexistence of discrete communities or community-types. In other words, each type of microhabitat would shelter a peculiar microcommunity of microarthropods. This fundamental hypothesis has been investigated in Belgian Lorraine by André (1981a) who distinguishes five major classes of arthropod communities.

Two of them are confined to special habitats or places at certain seasons, i.e.

(1) a scale insect community found on *Fraxinus* during the summer;

(2) a *Vertagopus arborea* community observed in foliose lichens in St-Mard during the winter.

The three other classes are directly related to the epiphytic cover, i.e.

(3) the *Dometorina plantivaga* community found in crustose epiphytes;

(4) the *Eueremaeus oblongus*/*Trichoribates trimaculatus* community sheltered by foliose lichens;

(5) the *Entomobrya nivalis*/*Cerobasis guestfalicus* community observed in fruticose lichens.

This paper aims to present data relating to the collembolan populations. In addition, the hypothesis will be investigated that Collembola taxocenoses are a consistent indicator of the arthropod communities composition, structure and diversity.

2. Material and methods

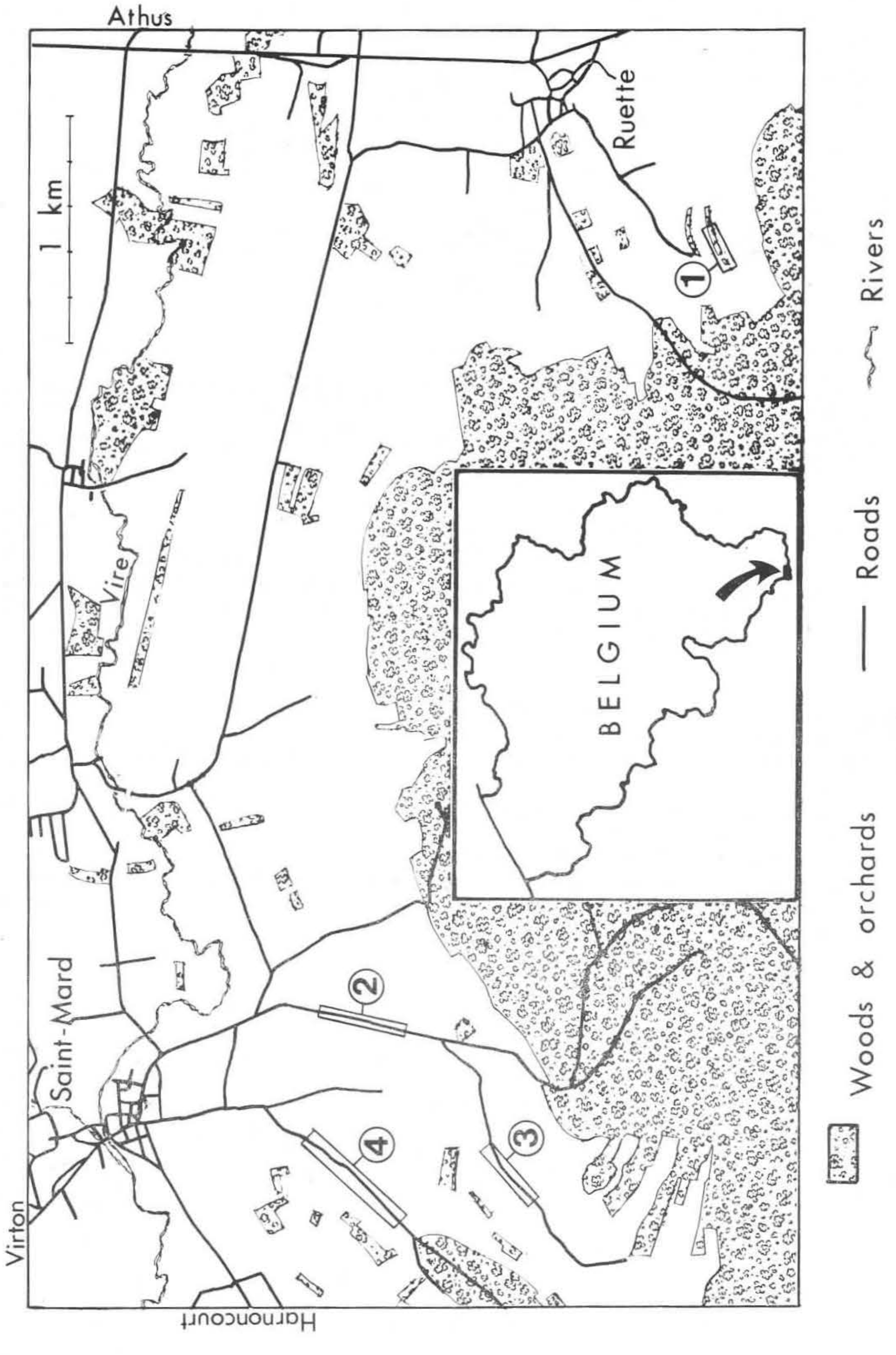
2.1. Location of study sites

The survey was undertaken in Belgian Lorraine (southern Belgium), an area well known for its purity of air and richness in corticolous lichens (Lambinon 1969). Three sampling sites are located at the same elevation (235—285 m) on the north slope of the Bajocian/Bathonian cuesta (Fig. 1). The Ruette site is a small wood previously described by André (1975); St-Mard A and B consist of trees planted along roads with little or no traffic.

2.2. Experimental design

A sample generally consisted of an epiphyte thallus taken with the underlying bark, possibly of a part of a large thallus or of a tuft of thalli in the case of small fruticose lichens. A sample thus

[1]) Contribution to the Vth International Colloquium on Apterygota, Louvain-la-Neuve, Belgium (23—26 August 1982), organized by C. Grégoire-Wibo and Ph. Lebrun. Paper read under the title "Notes on the ecology of corticolous Collembola".


Athus
Ruette
1 km
Vire
BELGIUM
Saint-Mard
Virton
Harnoncourt
1
2
3
4
Woods & orchards
Roads
Rivers

corresponds to a discrete unit representing a well-defined microhabitat and is characterized by the epiphyte, the phorophyte species and site. One hundred samples defined in the same way formed a set. Each set was composed of 4 series of 25 samples taken quarterly in relation to the four seasons. Eighteen sets of samples were sampled as detailed in the appendix.

2.3. Sample collection and processing

Samples were treated differently depending on the epiphytes. Sampling on hornbeam was done merely by brushing the bark (5×5 cm) as described by André & Lebrun (1979). Adjacent cores of foliose lichens and other crustose epiphytes with the underlying bark constituted a sample (25 cm² or less) and were cut out with 2 punches (dia. 14 and 23 mm); epiphytes were brushed or peeled off before putting the cores (bark discs + epiphytes) on the Berlese-Tullgren funnels for 8 days. Fruticose lichens are detached from bark with a knife and directly submitted to the funnel extraction. The samples were also smoked out at the beginning of the extraction.

2.4. Data analysis

Data were analyzed globally, i.e. data belonging to the same series are pooled together and form a relevé. For the community analysis, relevé totals are relativized to 100; in other words, species data are transformed in relative abundances. The OSUCL4 program (André 1981b), a classification around variable centres algorithm, was used to cluster the 72 relevés. Similarity between different classifications was estimated by using the GOODM program (Goldstein & Grigal 1972). As an ordination technique, detrended correspondence analysis (DCA) was selected and the DECORANA program (Hill & Gauch 1980) used.

3. Results

3.0. General

Although Collembola represent 38.34 % of the arthropods collected, only 24 species were recorded out of a total of more than 21,000 springtails. Seven of them were represented by more than 200 individuals and will be studied at the population level.

3.1. Species distribution

Figure 2 shows the distribution of the 7 most abundant species in the 3 study sites and the 3 types of epiphytes. Although densities are expressed in two ways depending on the type of epiphytes, it is obvious than most species are more abundant in foliose lichens than in other epiphytes.

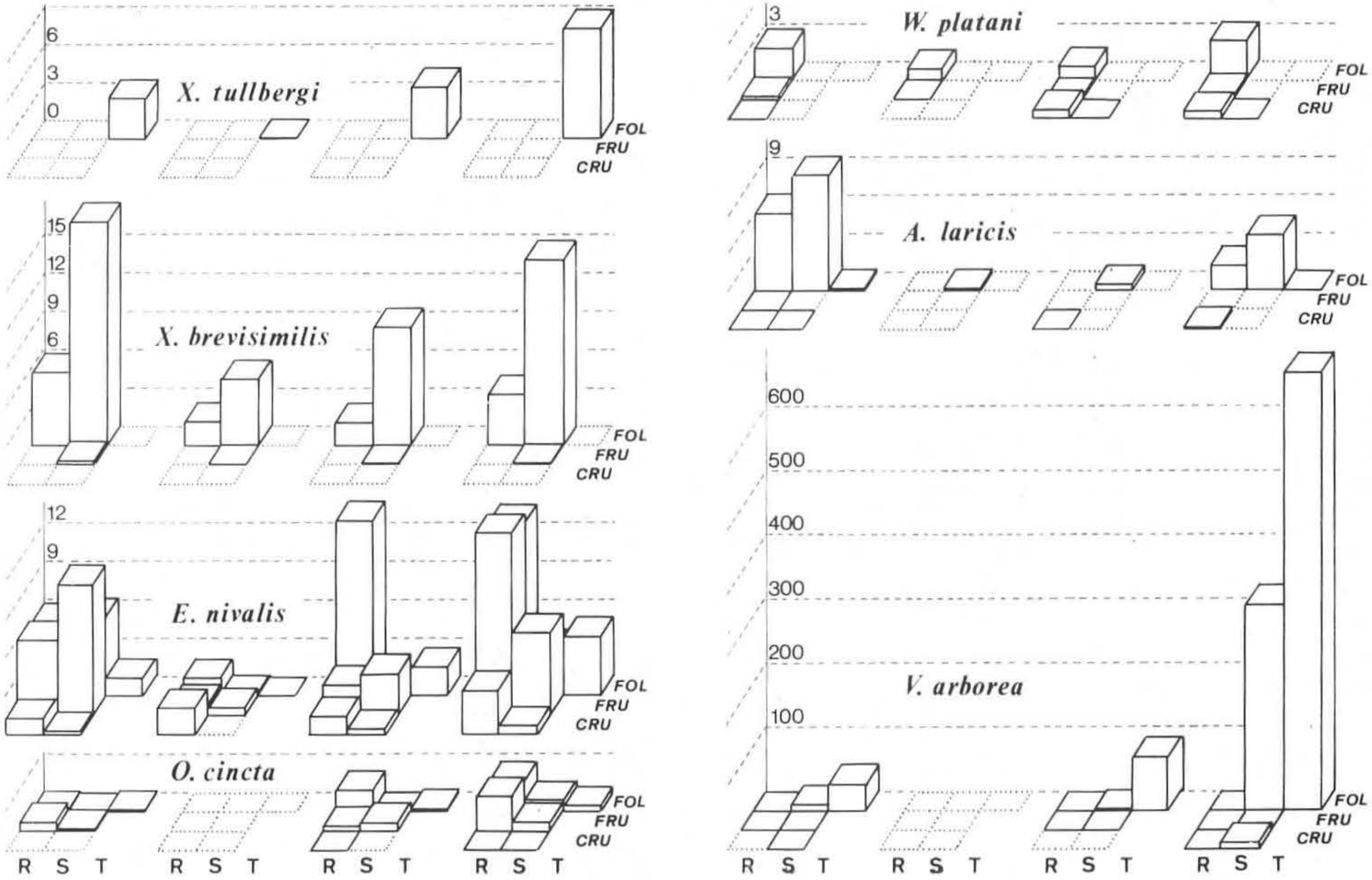
Both species of *Xenylla* are common in foliose lichens and rare or absent in crustose and fruticose epiphytes. *X. brevisimilis* is particularly abundant in *P. sulcata*, except on *Aesculus* where it is virtually absent. In this lichen, its density varies from approximately 5 (in Ruette) to around 30—35 individuals dm^{-2} (on *Populus* in St-Mard A) during the spring and winter periods. The 2 species are vicariant: *X. brevisimilis* was only found in Ruette and St-Mard A while *X. tullbergi* is restricted to St-Mard B.

Entomobrya nivalis and *Orchesella cincta* are both pretty common in foliose lichens whatever the site. However, they seem to be as abundant in fruticose lichens during the spring and winter periods. Their frequencies are even higher in fruticose than in foliose lichens (233/300, i.e. 78 % vs. 328/777, i.e. 42 % for *E. nivalis*; 27 vs. 8 % for *O. cincta*). In addition, *E. nivalis* turns out to be the most frequent species among the arthropods collected (662/1770 i.e. 37.40 %).

Willowsia platani and *Anurophorus laricis* are both common in foliose lichens and rare or absent in St-Mard B; *W. platani* seems even restricted to Ruette.

Vertagopus arborea is the most abundant collembolan and even the most abundant arthropod. It is very abundant in St-Mard B but is rare in Ruette. In winter, the local density may exceed 1,000 individuals dm^{-2} and even in some cases 2,000 individuals dm^{-2} (the maximum

Fig. 1. Study area. Site locations are indicated by figures. The inset map shows location of study area. 1: Ruette; 2: St-Mard A (stand of chestnut); 3: St-Mard A (stand of poplar); 4: St-Mard B.


X. tullbergi
0
3
6
X. brevisimilis
6
9
12
15
E. nivalis
9
12
O. cincta
W. platani
3
A. laricis
9
V. arborea
100
200
300
400
500
600
FOL
FRU
CRU
R S T
R S T
R S T
R S T

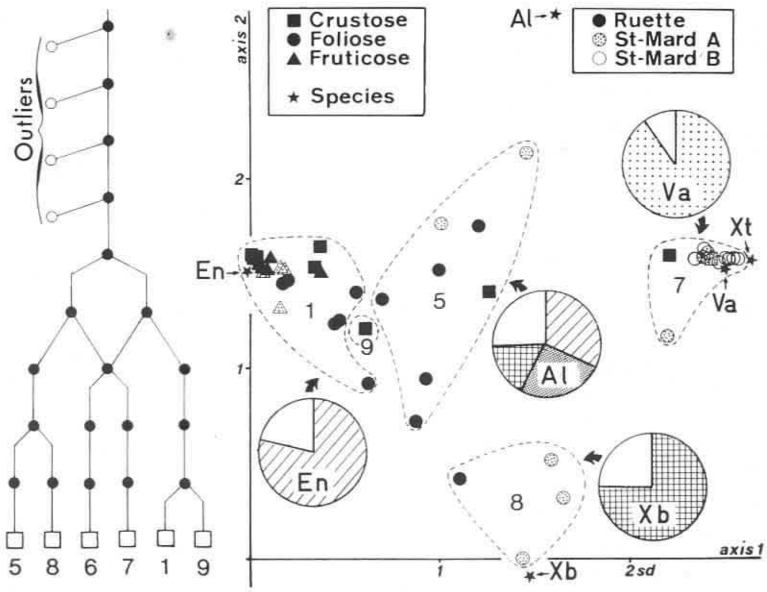


Fig. 3. Classification of the 72 relevés into 9 classes (left) and DCA ordination of species and the 51 relevés with more than 10 Collembola. Classes in the ordination are delineated by broken lines and designated by the same I.D. number as in the classification. Diagrams show the centroid composition of each class (but class 9). Stars indicate species (**Al:** *A. laricis;* **En:** *E. nivalis;* **Va:** *V. arborea;* **Xb:** *X. brevisimilis;* **Xt:** *X. tullbergi*).

observed is 2,736). This "winter species" (Pschorn-Walcher & Gunhold 1957) is absent in summer. This seasonal pattern, specially marked in *V. arborea* is in fact common to all collembolan species observed on bark.

3.2. Community structure and composition

The classification of the collembolan taxocenoses (Fig. 3, left) leads first to the rejection of outliers: summer series with no Collembola, relevés with just the only one specimen of a rare species, i.e. series with few individuals. A DCA ordination based on series comprising more than 10 individuals (this to avoid outliers to which DCA is very sensitive) leads to the recognition of 5 major classes, most defined by a dominant species as illustrated in Fig. 3 (right). Class 1 represents a taxocenosis dominated by *E. nivalis* (78.35 ± 15.23 %). Class 7 is dominated by *V. arborea* (90.37 ± 8.40 %) while class 8 is characterized by the abundance of *X. brevisimilis* (74.75 ± 12.70 %). Class 5 is characterized by the absence of a species representing more than 45 % of the Collembola and class 9 comprises only one relevé with *W. platani* as dominant species (64.71 %).

However, those different classes are difficult to relate to the habitat, except maybe class 8. Indeed, relevés forming class 8 were all observed in foliose lichens in Ruette and St-Mard A. No similar relationship emerges from the analysis of other classes.

Fig. 2. Distribution of 7 collembolan species in the 3 study sites (R: Ruette; S: St-Mard A; T St-Mard B) and in the 3 types of epiphytes (Fol.: foliose; Fru: fruticose; Cru: crustose) during the four seasons (four stereograms in line represent successively spring, summer, autumn and winter data). Densities are expressed either in number of individuals dm^{-2} (foliose and crustose epiphytes) or in number of individuals g^{-1} of dried lichen (fruticose lichens). Note that the density scale relating to *V. arborea* differs from the others.

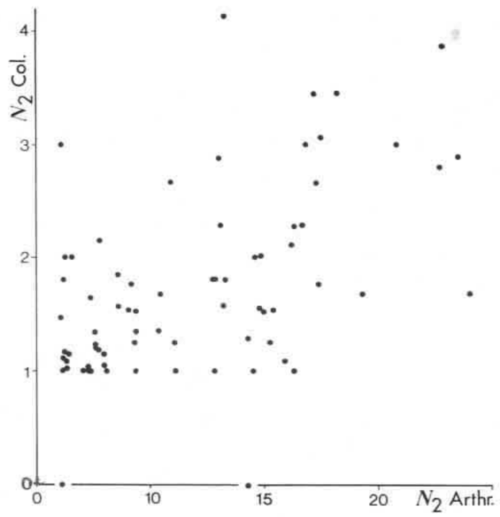


Fig. 4. Scatter diagram of collembolan species diversity (N_2 Col.) against species diversity of arthropods (N_2 Arthr.) in the 72 relevés. (Species diversity is estimated through HILL's (1973) index, N_2, which is the inverse of SIMPSON's index).

A comparison between the classification based on all the arthropods (see Introduction) and the above classification shows major divergences. Their similarity coefficient is equal to or lower than 0.34 whatever the partitioning level. Classes characterized in both classifications by the same dominant species do not coincide. For instance, the arthropod class characterized by the dominance of *E. nivalis* (see Introduction) comprises only relevés from fruticose lichens, which is obviously not the case of class 1 in Fig. 3.

Another method of comparing arthropod communities to collembolan taxocenoses consists in an analysis of their respective species diversity. In Fig. 4, collembolan species diversity in the 72 relevés is plotted against arthropod diversity. The correlation is rather poor ($r = 0.54$), which means that only 29% of the variance observed in collembolan diversity can be related to the variance of arthropod diversity.

4. Conclusions

During the course of this survey, a total of 24 collembolan species were recorded; the 7 most common species have already been found on bark. Two of these are very frequent and rather abundant in foliose and fruticose lichens, *E. nivalis* and *O. cincta*. *X. tullbergi*, *X. brevisimilis*, *A. laricis*, *W. platani* and *V. arborea* are the most abundant in foliose lichens. This study suggests that Collembola avoid crustose lichens but this observation should not be generalized. On the other hand, the collembolan distribution seems to be clearly related to sites, i.e. to the macrohabitat. Lastly, their abundance on bark is greatly affected by seasons and mostly by the relative humidity on the trunks and in the soil (BOWDEN et al. 1976, BAUER 1979). In other words, to parallel the cave organism classification, most Collembola are phloioxenous, a few species (as the 7 cited above) are phloiophilous but none are phloiobiontic (no species spends its whole life cycle on bark, at least in our region).

At the collembolan community level, five community-types have been identified and characterized by a dominant species (mainly *E. nivalis*, *V. arborea*, *X. brevisimilis*). The *V. arborea* taxocenosis was already cited by GISIN (1943). The *X. brevisimilis* taxocenosis could be equivalent to the *X. tullbergi* community observed by GISIN (1943) and CASSAGNAU (1961). Those taxocenoses are not related to a particular microhabitat. This would confirm

the syntaxonomy proposed by GISIN (1943) or CASSAGNAU (1961) which are based on factors of the macroenvironment (altitudinal gradient, soil vs. bark, etc.).

However, even if Collembola are a major component of the corticolous fauna, their study in isolation to other arthropod groups cannot lead to a real understanding of the identity of the corticolous microcenoses. Bark is not a permanent habitat for Collembola which often migrate up and down on the trunk depending on the season and the relative humidity[1]). Collembola include no phloiobiontic species and, beside, fewer phloiophilous species than other groups (as some mites). As a result, Collembola taxocenoses constitute a poor indicator of the structure and composition of corticolous microcommunities. They offer a descriptive example of the problem posed by the extrapolation of merocenosis properties to the whole community or biocenosis.

5. Appendix

Characteristics of the 18 sets of 100 samples
(epiphyte × phorophyte × site)

Crustose epiphytes:

1) *Protococcus viridis* on *Carpinus betulus* in Ruette,
2) *P. viridis* on *Aesculus hippocastaneum* in St-Mard A,
3) *Lecidea limitata* on *Populus × canadensis* in Ruette,
4) *Lecanora chlarotera* on *Fraxinus excelsior* in Ruette,
5) *L. chlarotera* on *P. × canadensis* in Ruette,
6) *L. conizaeoides* on *Betula pendula* in Ruette,
7) *L. conizaeoides* on *A. hippocastaneum* in St-Mard A;

Foliose lichens:

8) *Xanthoria parietina* on *P. × canadensis* in St-Mard B,
9) *Physcia pulverulenta* on *P. × canadensis* in St-Mard B,
10) *Parmelia acetabulum* on *P. × canadensis* in St-Mard B,
11) *P. acetabulum* on *F. excelsior* in Ruette,
12) *P. sulcata* on *F. excelsior* in Ruette,
13) *P. sulcata* on *P. × canadensis* in Ruette,
14) *P. sulcata* on *P. × canadensis* in Ruette,
15) *P. sulcata* on *A. hippocastaneum* in St-Mard A;

Fruticose lichens:

16) *Evernia prunastri* on *P. × canadensis* in St-Mard A,
17) *E. prunastri* on *F. excelsior* in Ruette,
18) *Ramalina farinacea* on *F. excelsior* in Ruette.

6. Acknowledgements

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ANDRÉ, H. M., 1983. Notes on the ecology of corticolous epiphyte dwellers. 2. Collembola. Pedobiologia **25**, 271—278.

Corticolous microarthropod communities have been analyzed in 3 sites located in Belgian Lorraine and related to their microhabitat (epiphytic cover), to phorophytes and sites. Although Collembola represent ca. 38% of the corticolous Arthropoda, only 24 species were recorded out of a total of more than 21,000 springtails. At the population level, seven common species are studied in relation to seasons and habitats. At the community level, collembolan taxocenoses are compared to the community classification obtained by studying Arthropoda as a whole; they turn out to be a poor indicator of the structure and composition of corticolous microcenoses.
Key words: Microarthropod, community, Collembola, corticolous, taxocenosis, microcenosis.